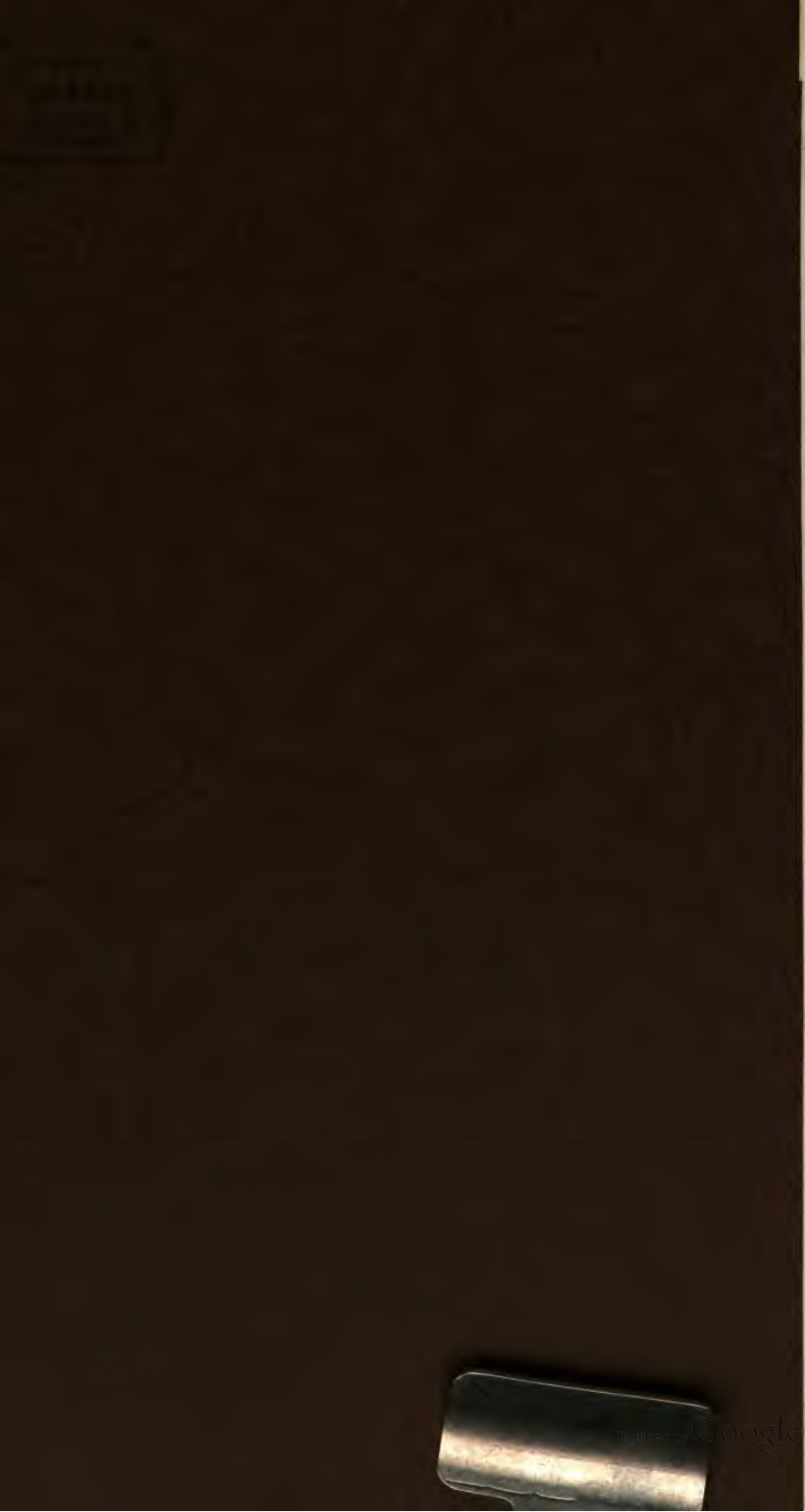

No. 1797

U.S. Ordnance dept.

HANDBOOK OF

RANGE-FINDERS

70 CM. AND 80 CM. BASE

FOR USE OF INFANTRY AND CAVALRY

WITH DESCRIPTION AND INSTRUCTIONS
FOR THEIR CARE AND USE

(*TWELVE PLATES*)

DECEMBER 9, 1915

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By order of the Secretary of War:

WILLIAM CROZIER,
Brigadier General, Chief of Ordnance.

CONTENTS.

SELF-CONTAINED BASE RANGE-FINDERS.

GENERAL PRINCIPLE.

If the length of one side and the value of any two angles of a triangle are known, the length of the other two sides of the triangle can be calculated.

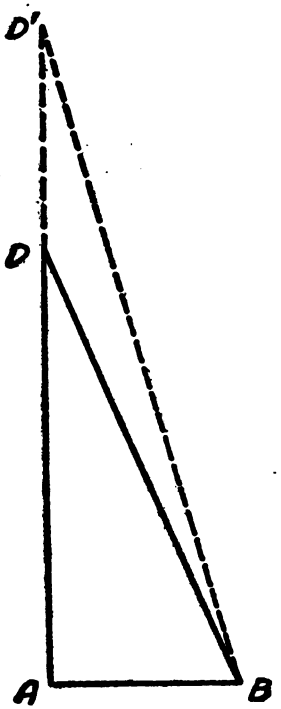


Fig. 1.

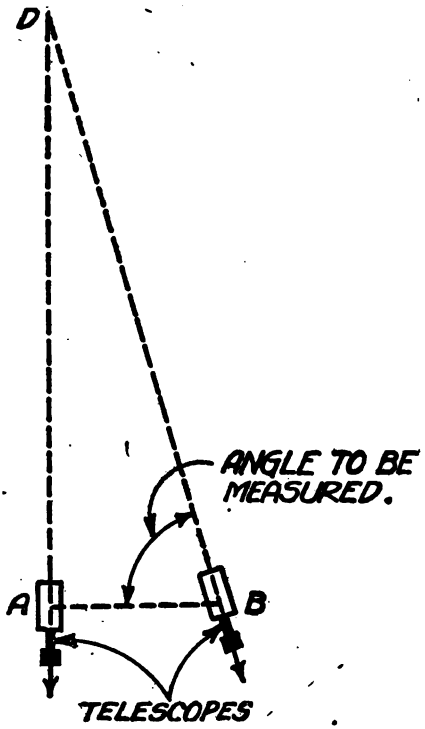


Fig. 2

Thus, in figure 1, if the length of the side AB and the angles BAD and DBA are known, the remaining sides AD and BD can be calculated.

If the length of the side AB is fixed and the angle BAD remains a right angle, then it is only necessary to measure the angle DBA in order to be able to calculate the lengths of the sides AD and BD. It will be seen from figure 1 that the longer the side AD becomes

(as AD'), the larger the angle DBA becomes (as D'BA), and that for any given length of AD there will always be a corrsponding value of the angle DBA.

Suppose, therefore, that a range-finder be constructed by placing a telescope at the point A and so arrange it that its axis or line of sight makes a right angle with the line AB. Place another telescope at the point B and so arrange it that the angle DBA which its line of sight makes with the line AB, can be measured. Then if the line AB is known and remains fixed, the length of the sides AD or the range of the object D from A can be computed. (See fig. 2.)

A table can be computed giving the length of the side AD of the triangle ABD for all values of the angle DBA from 0° to 90° for a fixed length of base AB. Then instead of graduating the angle-measuring scale on the telescope at B in degrees, graduate it with its corresponding values of the lengths of the side AD. We now have a range-finder which by measuring the angle DBA with the telescope at B will read directly the range of the object D from A.

To use such a range-finder, the observer at the telescope A would lay his telescope on object D, whose range from A is desired. As the telescope A is rigidly connected at right angles to the base line AB, the whole apparatus together with the telescope at B would be moved at the same time. The observer at B would then turn his telescope until the image of D coincided with the cross wire. The range AD could then be read directly from the angle scale on the telescope at B.

The single observer infantry and cavalry range-finder goes a step further and by means of reflexing prisms or mirrors permits a single observer to see the images from both telescopes A and B in a single eyepiece located midway between A and B. An observer looking into this eyepiece sees the field divided into two parts by a horizontal line. In the lower part of the field the observer sees the image from the telescope at A and in the upper part of the field the image from the telescope at B. There are other types of range-finders in which the field is divided into three parts.

In the single observer infantry range-finder when the telescope at B is turned, an object in the upper field observed through the eyepiece appears to move laterally across the field.

Plate I gives a diagrammatic sketch of a self-contained base, single observer range-finder.

A study of Plate I will show that the instrument is equivalent to two telescopes. On the left side is the fixed telescope corresponding to the telescope at A in the improvised range-finder just described. In the left telescope the light traverses the objective lens, the coincident prism D and the eyepiece consisting of the field lens G and the eyelens F. The line of sight of the left-hand telescope is turned

through 90° by means of the reflecting prism A. At the right-hand side is the movable telescope corresponding to the telescope at B in figure 2 of our improvised range-finder. In the right-hand telescope the light traverses the objective lens, the angle measuring prism P, the coincident prism D′, and the same eyepiece (G and F). As before, the line of sight of the right-hand telescope is turned through 90° by means of the reflecting prism B.

Instead of moving the telescope at the right-hand side mechanically, in order to measure the angle DBA (fig. 1), the line of sight of the telescope is moved optically by means of the reflecting prism P. This prism is sometimes called the angle-measuring prism or wedge. The reflecting prism P carries a range scale which is graduated directly in yards of range. Thus, moving the reflecting prism P laterally along AB corresponds to a movement of the line of sight of the right-hand telescope, and the angle which the line of sight of this telescope makes with the line AB (fig. 1) is read in terms of the range AD (fig. 1) on the range drum attached to the reflecting prism.

Referring to Plate I, if CA and C′B are parallel rays of light from an object at an infinite distance, they will meet at the center D. If the object is at the finite C and C″, then CA will be reflected to D as before, but C″B will be reflected to D′. The angle D′BD is equal to the angle C′BC″ and varies with the distance of the observed object. The ray BD′ could be made to take the direction of BD by revolving the reflector B, but the amount of this revolution is so small for moderate changes in range and so difficult for accurate measurement that the same result is obtained by the use of the prism P, the reflecting angle of which is very small.

A position of the reflecting prism P can be found varying with the distance of the observed object where the reflected ray will pass through the point D, thus meeting the ray CAD. The two coinciding images of the same prisms are so placed at the point D that they reflect the light from both ends of the range-finder into the eyelens F, and the images are actually found at a point in front of the eyelens, the position of the images depending upon the type of the instrument. Since there is a certain position of the prism P which will bring the two halves of the object into coincidence, then a suitably graduated scale attached to the prism and moving with it will record the distance of the object corresponding to the position of the prism.

In the actual range-finder various prism and lens combinations are employed in the place of the simple parts shown in Plate I, in order to obtain the desired erect or invert appearance of the partial images in the field of view (see Plate IV). All the optical elements are inclosed in a tube. As the tube is liable to be distorted as a result

of the effect of temperature changes, or of handling during the working of the instrument, it is necessary to adopt a type of end reflector that will not alter the direction of the beams of light entering the range-finder even if its position were varied by small amounts. Nearly all, except the earlier range-finders, are made with a prism, known as the pentagonal or Prandl prism, to take the place of the reflectors A and B on Plate I.

A prism of this type, designed to bend the rays of light through an angle of 90 degrees, consists of a block of glass having two reflecting faces placed at an angle of 45 degrees to one another. It is necessary that these two reflecting faces should be silvered, as the angle of incidence is within the critical angle of glass. Any rotation of such a prism about an axis perpendicular to the column normal plane of the two reflecting surfaces does not affect the direction of the double reflecting beam of light, as the effect of the rotation of one reflecting surface is exactly balanced by the equal rotation of the two reflecting surfaces.

Instead of using an angle-measuring prism like P (Plate I), which slides horizontally along the base of the range-finder, two rotating prisms are often used. These prisms are rotated in opposite directions by gearing connected to the range drum.

The actual arrangement of the optical parts used in the Goerz 80 cm. base range-finder are shown on Plate IV.

TYPES OF RANGE-FINDERS.

There are several different types of self-contained range-finders, three of which are described in this pamphlet, namely, the invert single-coincidence, the invert double-coincidence, and the erect double-coincidence types.

All the 80 cm. base Goerz range-finders issued to the service are of the invert single-coincidence type. The Bausch & Lomb instruments, 70 and 80 cm. base are of the invert double-coincidence type except 1—70 cm. base instrument No. 14 which is of the erect double-coincidence type.

In the invert single-coincidence type the entire upper field is inverted but not reversed, right or left, giving the effect as though the lower field was reflected in the sky.

In the invert double-coincidence type the narrow strip in the center of the field is inverted, the upper field remaining erect. This type gives a greater effective field for observation and permits coincidence to be made on two edges of the invert field when the target has a vertical straight line, as in a chimney or edge of a building. Its optics, however, are more complex.

The erect double-coincidence type is similar to the invert double-coincidence type except that the image in the central narrow strip is erect.

GENERAL INSTRUCTIONS.

The best defined part of an object should be selected to range on.

Coincidence should always be made in the center of the field of view and if possible with the dividing line at right angles to the object observed.

Upon the accuracy of the coincidence setting depends the accuracy of the range determination. No difficulty should be experienced on the part of the observer in obtaining good results after a little practice or even at the first attempt, but in range finding as in anything else accuracy increases with practice.

It has been found that different observers have what might be called personal errors which diminish as their experience increases. The range observer should therefore be given every opportunity for practice in measuring angles and ranges, and in making the halving adjustments. When both edges of the object are equally well defined the observer should always make his coincidence on the same edge, right or left. Individual observers have obtained better results by so doing than if they used the right edge sometimes and the left edge at other times. It is advisable when time permits to obtain the range by taking the mean of several consecutive readings.

With targets moving laterally across the field it is best to adjust the images on the edge from which the targets are moving, and to make the measurements for range while the target runs across the field.

Before observing range, the adjustments for height and for distance should be tested, and corrected if necessary. Adjustment for height should always be made before adjustment to correct for errors in distance. See the descriptions of the different range-finders for the methods of making the adjustments for height and distance.

GOERZ RANGE-FINDER.

(80 CM. BASE.)

EQUIPMENT AND GENERAL DESCRIPTION.

The instrument (Plates V, VI, and XII) consists of the range-finder, the tripod, the adjustment bar, the accessories, and the carrying case.

The principal parts of the range-finder proper are the—

A.—Eyepiece.
B.—Finder.
C.—Measuring screw.
D.—Range scale.
E.—Protective cap for height adjustment screw.
F.—Protective cap for range adjustment screw.
K.—Entrance apertures.
K.′
L.—Locking hook.

The tripod consists principally of the—

M.—Hook bolt.
N.—Legs.
O.—Metal tubing extension.
P.—Locking screws for O.
Q.—Locking lever for N.
R.—Casing.
S.—Locking screw for spur.
T.—Spur.
U.—Locking screw for pivot.
V.—Locking screw for tilting joint.
W.—Elevation screw.

The accessories are comprised of—

X.—Adjustment bar.
Y.—2 color screens.
Z.—2 sun shades.
1 piece shamois skin.
1 brush.

Optical data:

Invert single-coincidence type.
Magnifying power, 10.
Actual field of view in degrees, 4°.
Entrance pupil, 1 inch.
Exit pupil, 0.1 inch.
Shortest distance measurable, 400 yards.

Plate IV shows the optical elements mounted in the same relative position as in the instrument.

The accuracy of the instruments, even under the most favorable conditions, will be unavoidably influenced by a known error. In the following table the lowest values of these errors are given, but when the air is unsteady or the target is unfavorable, these errors may be increased five times.

	Yards.		Yards.
400 yards	1	900 yards	4.9
500 yards	1.25	1,000 yards	6
600 yards	2	1,500 yards	12.5
700 yards	3	2,000 yards	23.8
800 yards	3.8	3,000 yards	54

OPERATION.

This type of range-finder may be used in the prone, kneeling, or standing position. The spur (T), Plate VI, is used as a support for the range-finder when in a prone position. Where the soil is soft the spur is pushed as one piece vertically into the ground. For use on hard soil the three parts composing the spur are spread and used as a short tripod. For use with the tripod the spur is folded together, inserted into the casing R of the tripod, and locked securely by locking screw S. The instrument can also be used in the prone and kneeling positions by supporting it with the hands.

For use in standing position the tripod legs must first be lengthened by loosening locking screws P and allowing metal tubing extension O to drop out, after which locking screws P are again tightened. If necessary, the spur T can be adjusted in the casing R to suit the height of the observer's eyes.

Take the range-finder from the carrying case, with eyepiece turned toward the observer, and seat the instrument firmly on the tripod. Remove the protective hoods from the entrance apertures and put on sun screens Y if necessary, turn range-finder toward the target and fasten locking screw U, release locking screw V, turn range-finder so that its longitudinal axis is horizontal and relock screw V. Dismounting is accomplished in the reverse order.

ADJUSTMENTS.

A. ADJUSTMENT FOR HEIGHT.

When in sighting at an object the partial images do not touch the dividing line with similar points, so that one image reaches the dividing line before the other (fig. 6, Plate II), the instrument is not in adjustment for height.

To correct this error the range-finder must be trained at an object having a sharply defined horizontal line or particularly promi-

nent point, and the images brought laterally exactly opposite each other by means of the measuring screw. The protective cap E, Plate VI, is then raised and by means of the height-adjustment screw the images of the clearly defined line or prominent point, in both the upper and lower fields, are brought equidistant from the dividing line. Having made this adjustment, test it by turning the elevating screw W until similar points just touch the dividing line (see fig. 5, Plate II). The adjustment made, the protective cap is replaced to guard against unauthorized or accidental shifting.

B. ADJUSTMENT FOR DISTANCE.

The adjustment for the correction of errors in distance is made with the adjustment bar, Plates V and VI. This bar is set up not less than 100 yards from the range-finder and directly facing it. The adjustment bar is provided with a finder, by means of which the axis of the bar can be placed at right angles with the line joining the range-finder and the center of the adjustment bar. Both ends of the adjustment bar are marked with a black line. The distance between these lines is the same as that between the centers of the entrance apertures of the range-finder. The targets are made to coincide as shown in figure 9, Plate III, by means of the measuring screw (C) and the reading of the range scale noted.

This should be repeated several times to insure accuracy, and if the average reading does not show infinity a readjustment must be made. This adjustment is made by bringing the infinity setting of the range drum opposite the index and making coincidence of the targets by means of the range-adjustment screw (F), Plate VI. To insure accuracy coincidence should be made several times, noting the readings of the scale on the range-adjustment screw. The final adjustment should then be made by setting the range-adjustment screw at its average setting. The protective cap should then be closed and secured to prevent accidental or unauthorized disarrangement.

MEASURING RANGES.

The eyepiece is provided with an adjustment for individual correction, equipped with a diopter scale. If this correction is not known it should be determined before any attempt is made to measure ranges. The determination of the individual correction is made by turning the eyepiece until the details appear sharply defined in the field of the range-finder. The resulting number on the diopter scale should then be memorized for future use. The color screen is provided to protect the eyes of the observer from a glare of light.

The range-finder having been set approximately on the target (if necessary, by means of the open sight), the object is looked for in

the field of view. Movement in azimuth is accomplished by turning the range-finder on the tripod pivot after loosening locking screw (U), (see Plate VI). For use with stationary targets this screw is relocked after the instrument is properly set. The movement in elevation is accomplished by means of the elevation screw (W), Plate V.

The field of view of a range-finder of the single coincidence invert type is divided into two parts by a horizontal line. In the lower part the image of the object appears upright, while in the upper part it is inverted (fig. 3, Plate II).

By turning the height adjustment screw the images are lined up so that the proper points will touch the dividing line (fig. 4, Plate II).

By turning the measuring screw (C), Plate VI, the image is shifted laterally until similar points of the object are exactly above one another (fig. 5, Plate II). The distance is then read on the range scale.

With targets which have no prominent vertical lines or points, but show horizontal lines, such as tops of heights, entrenchments, etc., the distance is measured on the horizontal line by setting the instrument vertical (fig. 10, Plate III). For this purpose the locking screw is loosened and the range-finder turned down on the left until vertical. Measurements are taken in the same manner as described above. The image first appears as illustrated in figure 7, Plate II. By turning the measuring screw the partial images are shifted so that the horizontal line is continued exactly on the dividing line (fig. 8, Plate II).

BAUSCH & LOMB RANGE-FINDER.

(70 CM. BASE.)

EQUIPMENT AND GENERAL DESCRIPTION.

The instrument (Plates VII and VIII) consists of the range-finder proper, the tripod, the accessories, and the carrying cases (Plate IX).

The principal parts of the range-finder proper and the tripod mount are the—

A.—Entrance apertures.
B.—Range roller.
C.—Revolving collar (covering rollers).
D.—Height-adjustment roller.
D′.—Range-adjustment roller (not seen).
E.—Eyepiece.
F.—Window for illuminating range scale.
G.—Window for illuminating adjusting marks.
H.—"Air" and "field" adjustment.
I.—Locking screw for pivot.
J.—Releasing plunger.
K.—Elevation screw.
L.—Casing.
M.—Spur.
N.—Shoulder strap.
P.—Eyepiece cover.
R.—Range-adjustment levers.
S.—Reference scale.
T.—Open sight.
V.—Locking lever for leveling device.

The accessories are comprised of—

O.—2 color screens, 1 brush, and 1 piece of chamois.

The carrying case equipment (Plate IX) consists of the—

W.—Range-finder, case with tripod.
X.—Range-finder support.
Y.—Tripod mount case.

Optical data:

Invert double-coincidence type.
Magnifying power, about eleven times.
Actual field of view in degrees, 4°.
Entrance pupil, 1 inch.
Exit pupil, 0.1 inch.
Shortest distance measurable, 400 yards.

The accuracy of the measurements even under the most favorable conditions will be unavoidably influenced by a known error. In the following table the lowest values of these errors are given, but when the air is unsteady or the target is unfavorable these errors may be increased five times.

	Yards.		Yards.
400 yards	0.7	900 yards	3.9
500 yards	1.1	1,000 yards	4.4
600 yards	1.6	1,600 yards	11
700 yards	2.2	2,000 yards	17
800 yards	2.8	3,000 yards	39

OPERATION.

The range-finder may be used in the prone, kneeling, or standing position. The spur M is used as a support for the range-finder when in a prone position. Where the soil is soft, the spur is pushed as one piece vertically into the ground. For use on hard soil, the three parts composing the spur are spread and used as a short tripod. For use in the standing position without the tripod, a range-finder support is furnished which is hung on the observer's shoulder and holds the instrument to the required height.

This instrument can not be adjusted to the vertical position on the tripod. For use with the tripod, the spur is folded together, inserted in the casing L of the tripod, and clamped securely. For use in the standing position, the tripod legs are spread and the spur can be adjusted in the casing to suit the height of the observer's eyes.

ADJUSTMENTS.

A. ADJUSTMENT FOR HEIGHT.

If, when in sighting at an object, the partial images do not touch with similar points on the line on which coincidence is to be made, the instrument is out of adjustment for height. To correct for this error, the range-finder must be trained on some object having sharply defined details and the images brought exactly opposite each other by means of the range roller (B), Plate VII. The revolving cover (C) is moved back to uncover the height adjustment roller (D′) and the images of similar points of the object brought equidistant from the dividing line upon which coincidence is to be made by turning the roller (D′). Both images may then be made to touch the dividing line simultaneously by turning the elevation screw (K). The height-adjustment roller should always be covered when not in use.

B. ADJUSTMENT FOR DISTANCE.

These Bausch & Lomb range-finders have no adjustment bar, but are provided with an internal adjusting device. The adjustment for correction of errors in distance is made as follows: Turn down both

range-adjustment levers (R), Plate VIII, until vertical; this throws the adjustment marks into the field of view. The locking screw on the revolving collar (C), Plate VII, marked "Stadia adjustment" is then released and the collar turned until the mark "Stadia adjustment" is opposite the arrow on the instrument. The range-adjustment roller (D′) is now exposed. The range scale having been previously set to read infinity the single adjusting mark is brought exactly in the middle of the double adjusting marks by turning the range adjustment roller (D′) (see fig. 11, Plate III). The position is then read on the scale (S), Plate VIII. Should there be any variation in the reading of the scale (S) in the several trials the final adjustment should be made by setting the scale at the average setting. The revolving cover should then be replaced and the range adjustment levers turned to a horizontal position.

MEASURING RANGES.

The eyepiece is provided with an adjustment for individual correction, equipped with a diopter scale. If this correction is not known it should be determined before any attempt is made to measure ranges. The determination of the individual correction is made by turning the eyepiece until the details of distant objects appear sharply defined. The resulting number on the diopter scale should then be memorized for future use.

The range-finder having been set approximately on the target, the instrument is leveled by loosening the locking lever (V). Movement in azimuth is accomplished by loosening the locking screw (I). Movement in elevation is accomplished by the elevating screw (K), by means of which the points to be ranged on are brought to the coincidence line. These range-finders being of the double-coincidence type have a field divided into three parts. The lower field is erect, the narrow band in the center is inverted and the upper field is erect. Coincidence therefore may be made on either dividing line. These instruments are provided with an "air" and "field" adjustment by which the position of the inverted image may be shifted to make coincidence on either line of separation. When the knob (H) is turned in the direction of the arrow marked "field," coincidence is had on the lower line of separation; when turned to the arrow marked "air," coincidence is had on the upper line. By turning the range-roller (B) the image is shifted laterally until the vertical edge or points range on arc exactly above one another; the range is then made on the scale.

No provision has been made in these mounts for rotating the range-finder in a vertical position.

BAUSCH & LOMB RANGE-FINDER.

(80 CM. BASE.)

EQUIPMENT AND GENERAL DESCRIPTION.

The instrument (Plates X, XI, and XII) consists of the range-finder proper, the tripods the accessories, and the carrying cases.

The principal parts of the range-finder proper and of the tripods and mount are:

A —Entrance apertures.
B —Range roller.
C —Height-adjusting roller (under slide).
D —Range-correction knob.
F —Eyepiece.
G —Range scale (under slide).
H —Range-correction reference index.
I —Cover for gimble joint screw.
J —Internal adjusting levers.
M —Amber and smoked glass lever.
O —Eyepiece cover.
P —Open sight.
E —Instrument-carrying strap.

Short tripod and mount:

Q —Releasing plunger.
R —Tilting knob.
S —Elevation knob.
T —Azimuth clamp knob.
N —Spur.

Long tripod:

W —Tripod legs.
U —Tripod clamp knob.
V —Tripod casing and head.

The accessories are comprised of—

K —Range correction key.
1 brush and 1 piece of chamois.

The carrying case equipment consists of—

(*a*) A large case, with straps, for range-finder proper and long tripod. A container is provided in the end of this case for the accessories.

(*b*) A small carrying case (L) for tripod mount and short tripod.

Optical data:

Invert double-coincidence type.
Actual field of view in degrees, 4°.
Power, 10.5.
Entrance pupil, 0.99 inch.
Exit pupil, 0.09 inch.
Shortest distance measurable 400 yards.

The accuracy of the measurements even under the most favorable conditions will be unavoidably influenced by a known error. In the following table the lowest values of these errors are given, but when the air is unsteady or the target is unfavorable, these errors may be increased five times.

	Yards.		Yards.
400 yards	1	900 yards	4.9
500 yards	1.25	1,000 yards	6
600 yards	2	1,500 yards	12.5
700 yards	3	2,000 yards	23.8
800 yards	3.8	3,000 yards	54

OPERATION.

This type of range-finder can be used in the prone, kneeling, or standing position. The spur is used as a support for the range-finder when in the prone position. Where the soil is soft, the spur is pushed as one piece vertically into the ground. For use on hard soil, the three parts composing the spur are spread and used as a short tripod. For use with the long tripod, the spur is folded together and inserted into casing (V), Plate X, of the tripod, and locked securely by means of the tripod clamp knob (U). The spur should be adjusted in the tripod casing to suit the height of the observer's eye. The instrument can also be used in the prone or kneeling position by supporting it with the hands.

ADJUSTMENTS.

A. ADJUSTMENT FOR HEIGHT.

If, when in sighting at an object, the partial images do not touch the dividing line with similar points, so that one image reaches the dividing line before the other (fig. 6, Plate II), the instrument is not in adjustment for height. To correct this error, the range-finder must be trained at an object having a sharply defined horizontal line or particularly prominent point and the images brought laterally exactly opposite each other by means of the measuring screw. The height-adjusting roller (c) Plate X is then exposed by moving the slide marked "halving adjuster" to one side and the adjustment made by turning the roller until the images of a clearly defined line or prominent point are brought equidistant from the dividing line in each field (see fig. 4, Plate II). The height of the

images in both fields is controlled by means of the elevation knob (S), Plate X. The adjustment made, the protective slide is replaced to guard against unauthorized or accidental shifting.

B. ADJUSTMENT FOR DISTANCE.

See the description of the method of making this adjustment for the 70-cm. Bausch & Lomb range-finder, page 18.

The range scale should be set to read infinity before making this adjustment. Bring the two triple mirror prisms in use by pushing the actuating levers (J), Plate XI, downward. The illuminator for the adjusting mark is opposite the eyepiece. This illuminates the adjusting mark on the outward prism and reflects it back through the ocular prism, right telescope, right triple-mirror prism, left triple-mirror prism, left telescope, and to the ocular prism again, where this reflected mark will appear in the same horizontal plane as the index slot, and, if the instrument is not in adjustment, will not be equidistant from the sides of the slot. Place key on range correction knob (D), Plate X, and turn until the reflected mark is equidistant from the sides of the index slot. (See fig. 12, Plate III.) Observe the reading on the range correction reference index (H), Plate XI. Repeat this operation at least three times and then set index (H) at the mean of the three readings. Throw the triple-mirror prisms out of the field by means of the actuating levers (J) and remove the adjustment key. The instrument should now be in adjustment for reading correct ranges.

MEASURING RANGES.

The eyepiece is provided with an adjustment for individual correction, equipped with diopter scale and index. If this correction is not known, it should be determined before any attempt is made to measure ranges. The determination of the individual correction is made by turning the eyepiece until the details of distant objects appear sharply defined. The resulting number on the diopter scale should then be memorized for future use.

Having the instrument mounted upon either tripod, rotate the protective bands so as to expose the entrance apertures (A), release azimuth clamp (T), and turn the range-finder toward the target. Tilt the range-finder until approximately horizontal by means of the tilting knob (R), and look for the target in either open sight (P), using the elevation knob (S) to elevate or depress the line of sight as necessary.

These range-finders being of the double-coincidence type have the field divided into three parts. The lower field is erect, the narrow band in the center is inverted, and the upper field is erect. Coincidence, therefore, must always be made on the lower dividing line.

Having placed the image of the target in the center of the field of view, elevate or depress the line of sight by means of the elevation knob (S) until similar points of the target, in the upper and lower fields, are equidistant from the lower dividing line. Turn the range roller (B), Plate X, until similar points of the image in the central field are exactly above the same points in the lower field. (See fig. 5, Pl. II.) The range is then read on the range scale.

With targets which have no vertical points or lines but show horizontal lines, such as tops of heights, intrenchments, etc., the ranges are measured on the horizontal line by holding the instrument vertical.

In this connection see also paragraph "General instructions," page 11 of this pamphlet.

CARE AND PRESERVATION.

Under no circumstances shall any range-finder be disassembled or adjusted except by a skilled mechanic upon order by an Ordnance Officer or by an arsenal especially equipped for instrument work. The interior is sealed against dust and moisture and any disassembling will unseal the internal parts and may cause serious damage to the instrument. Every precaution should be taken to preserve the range-finder from unnecessary injury. It should not be thrown on the ground or subjected to any avoidable shocks, strains, neglect, or other ill usage. To care for the instrument properly those responsible for it should familiarize themselves with the functions of its various parts, the methods of adjusting, and the proper method of caring for the mechanical and optical parts.

The instrument should be kept in a dry place. The working parts should be oiled regularly though sparingly with oil issued by the Ordnance Department. Proper care should be taken that no oil drops upon or reaches the optical surfaces or other parts which do not require oiling.

The range-finder should be protected as much as possible in wet weather. When rain ceases or operations are over the outside of the range-finder should be wiped off with a cloth.

The end windows, the scale window, and the eyepiece should be wiped with a piece of clean chamois skin especially kept for the purpose. Dry dust is removed with the brush.

The metal work should be rubbed down with a dry cloth; cleaning paste must not be used on any part of the instrument.

The greatest care should be taken not to allow any oil or grease to get on any of the windows, lenses, or prisms, nor should they be touched with the fingers.

If in any case moisture is found collected on the inner surface of the windows or the internal optical parts the end plates to which the padded buffers are attached should be removed for a short time to allow a current of air to pass through the tube, but this should only be done in dry weather, never in rain or fog, or if smoke or dust is about the range-finder.

All work on the range-finder, such as unnecessary turning of screws, etc., not incident to its use or cleaning, is strictly forbidden.

WAR DEPARTMENT,

OFFICE OF THE CHIEF OF ORDNANCE,

Washington, December 9, 1915.

Form No. 1797.

Ed. June 16-17—8,000.

PLATE I.

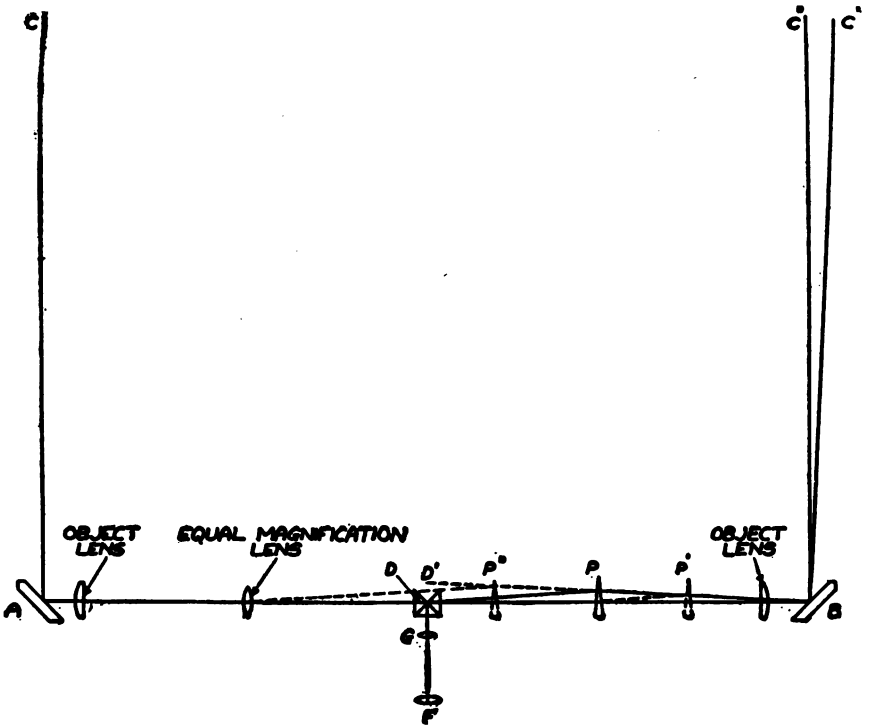


DIAGRAM TO ILLUSTRATE THE GENERAL PRINCIPLE OF RANGE-FINDERS.

FIG. 3.

FIG. 4.

FIG. 5.

FIG. 6.

FIG. 7.

FIG. 8.

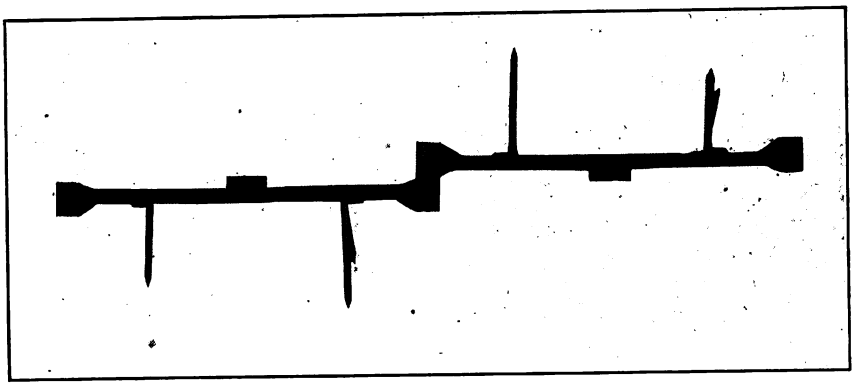


FIG. 9.

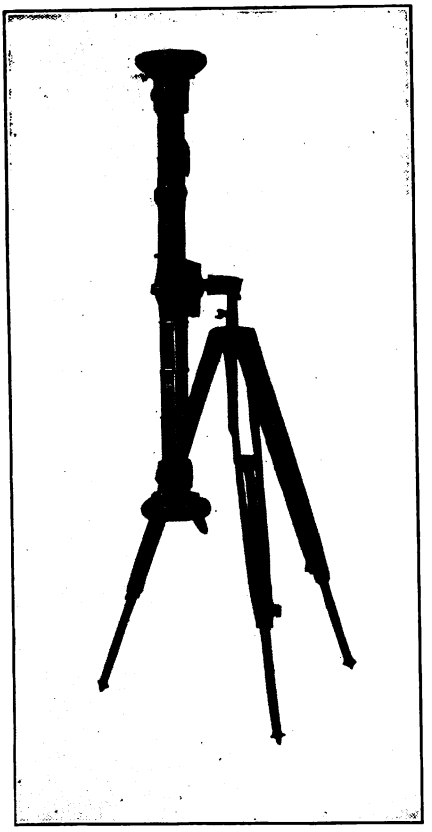


FIG. 10

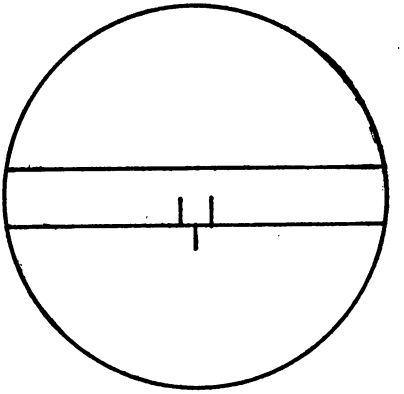


FIG. 11.

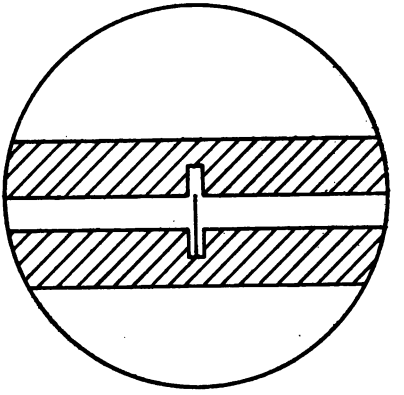
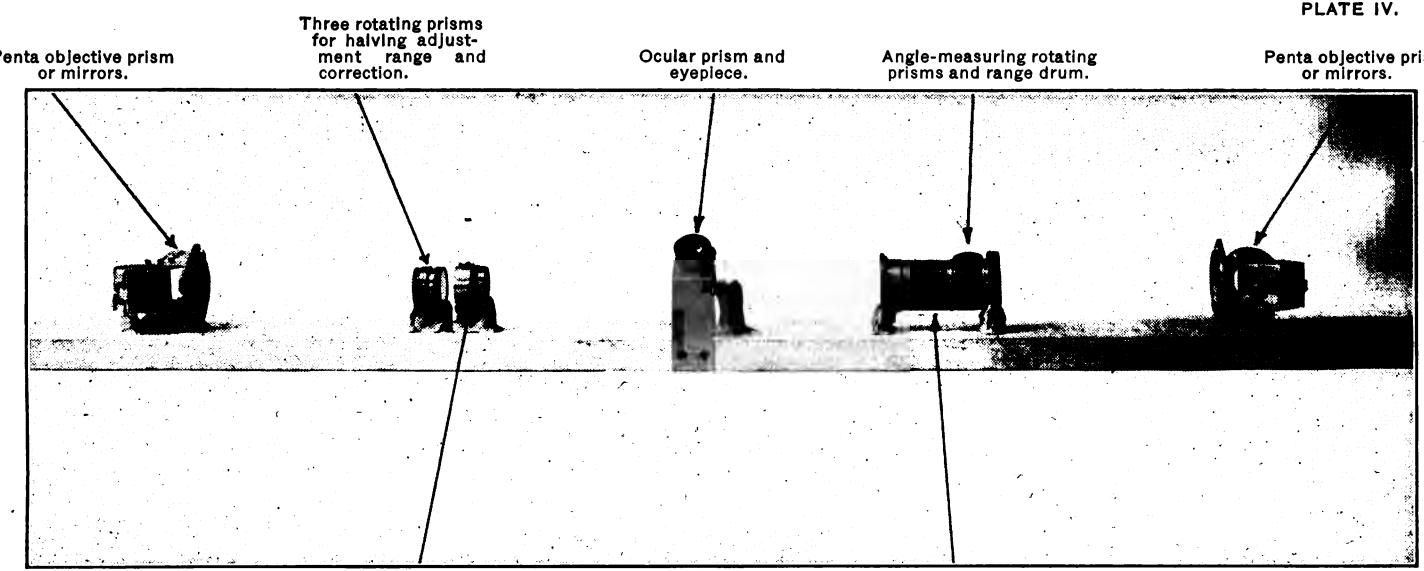
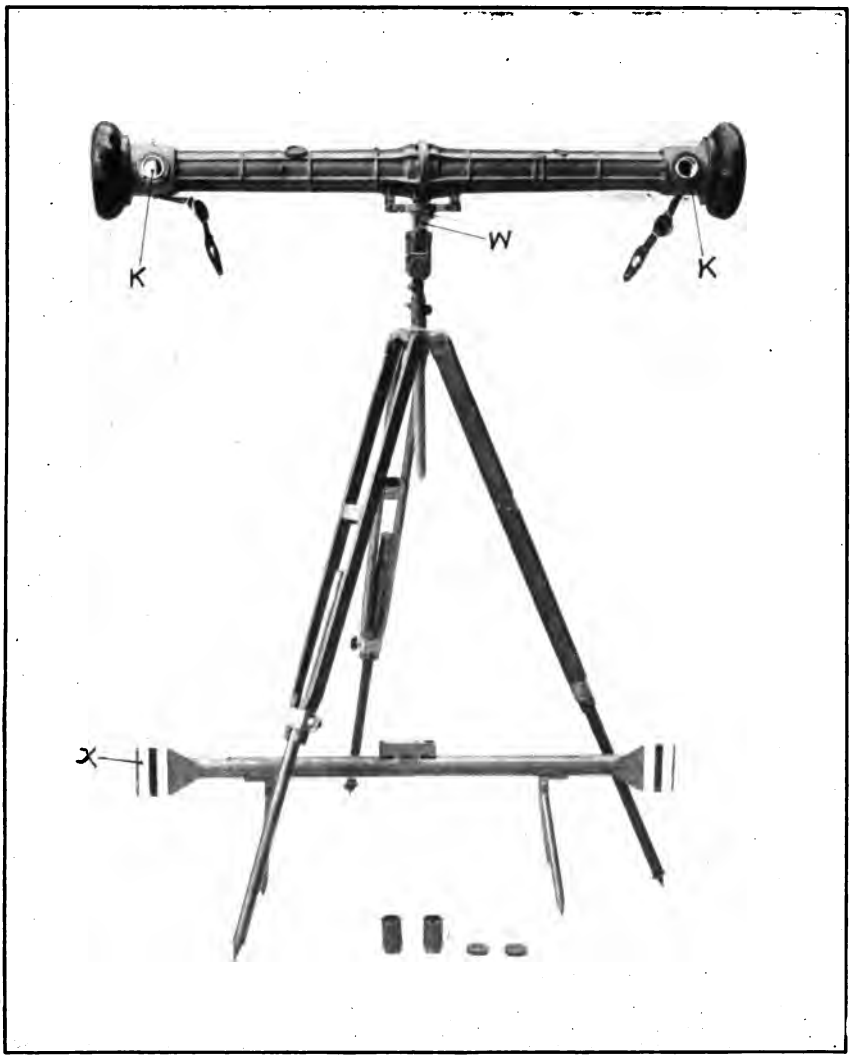


FIG. 12.

PLATE IV.

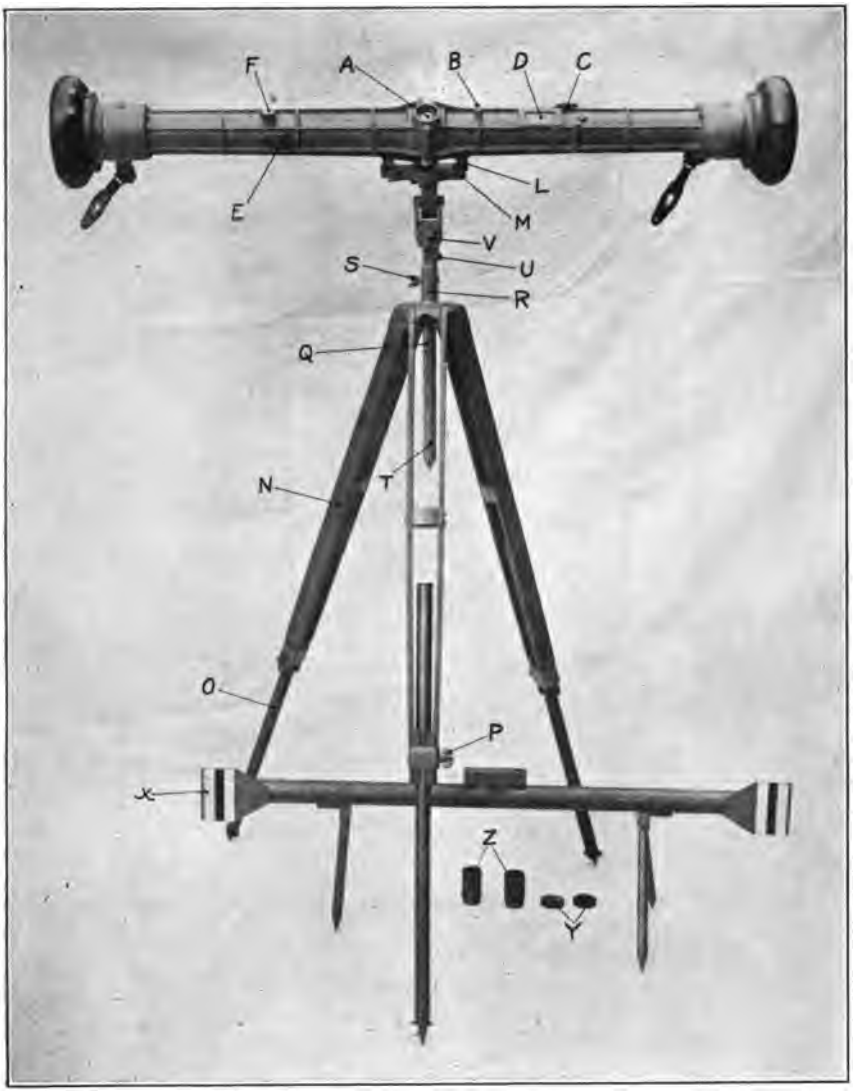


OPTICAL ARRANGEMENT FOR GOERZ, 80 CM. BASE, RANGE FINDER.

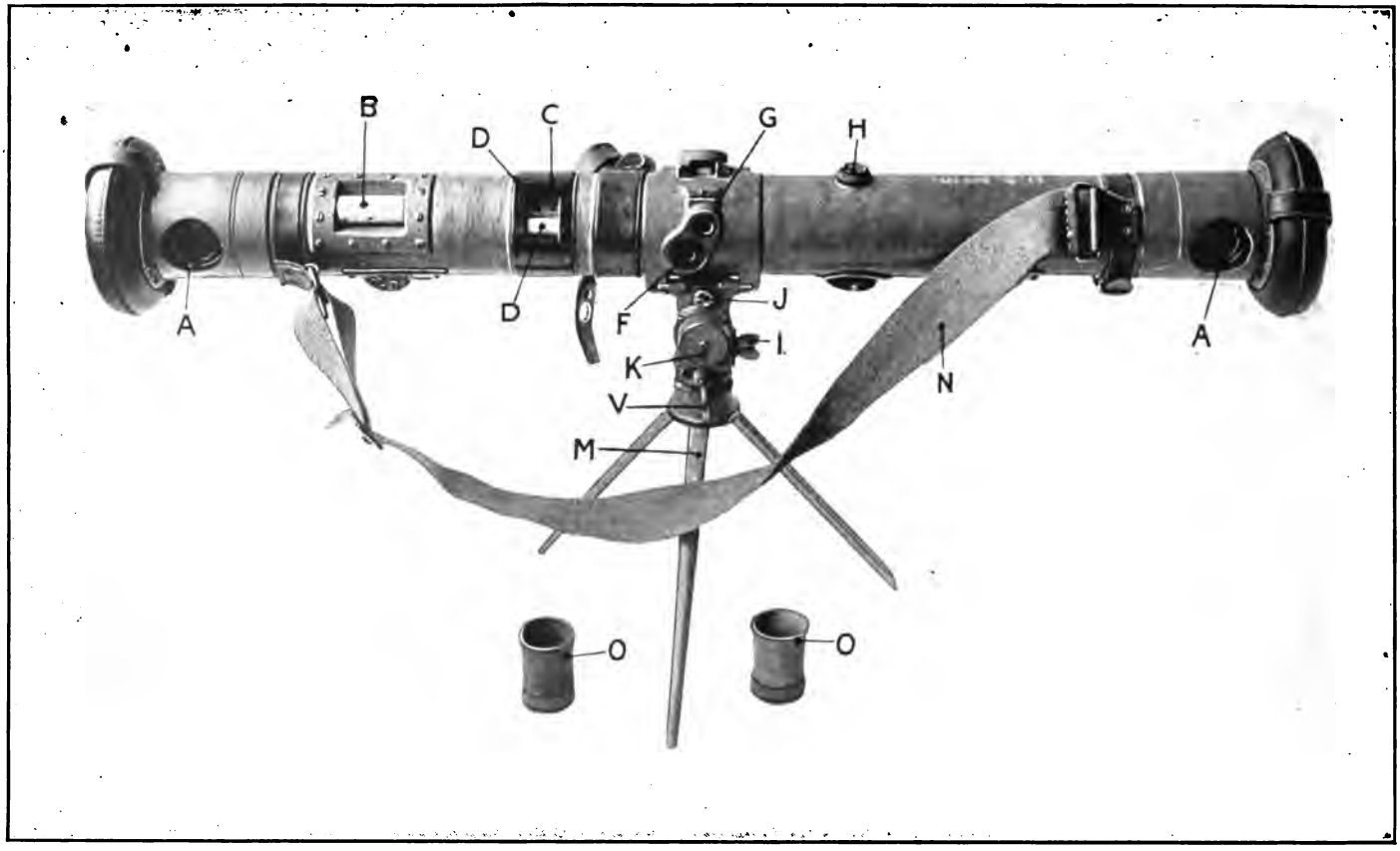


GOERZ, 80 CM. BASE, RANGE FINDER. FRONT VIEW.

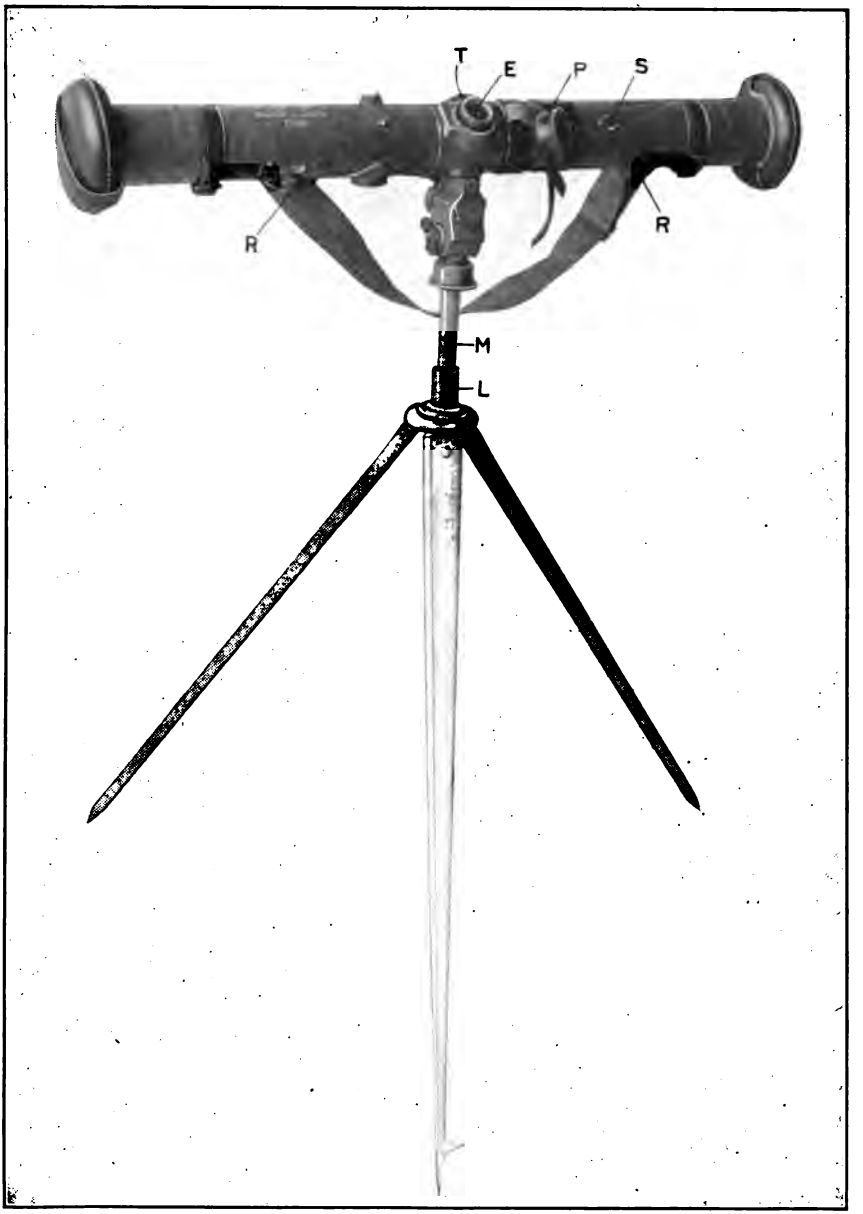
PLATE VI.



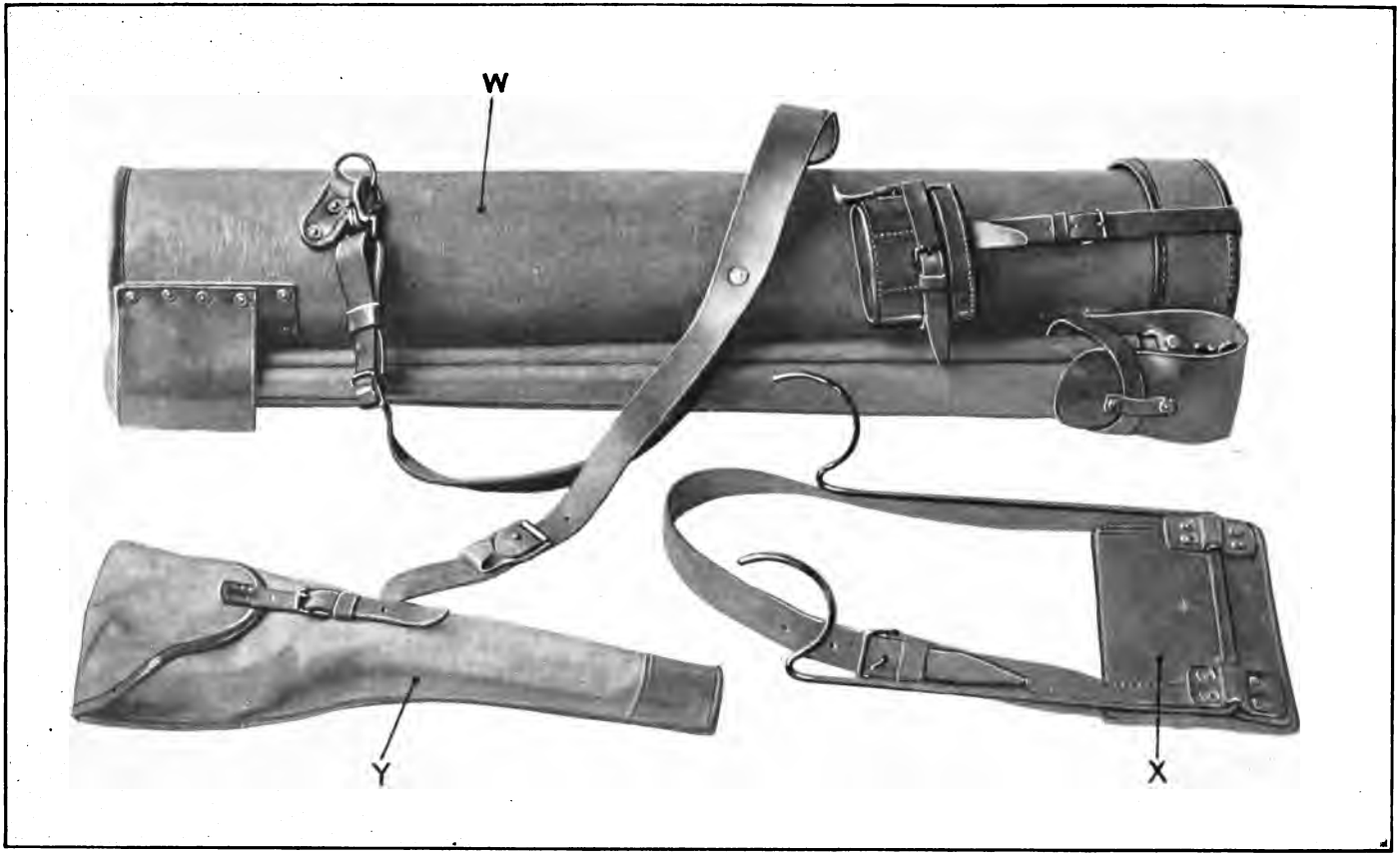
GOERZ, 80 CM. BASE, RANGE FINDER. REAR VIEW.



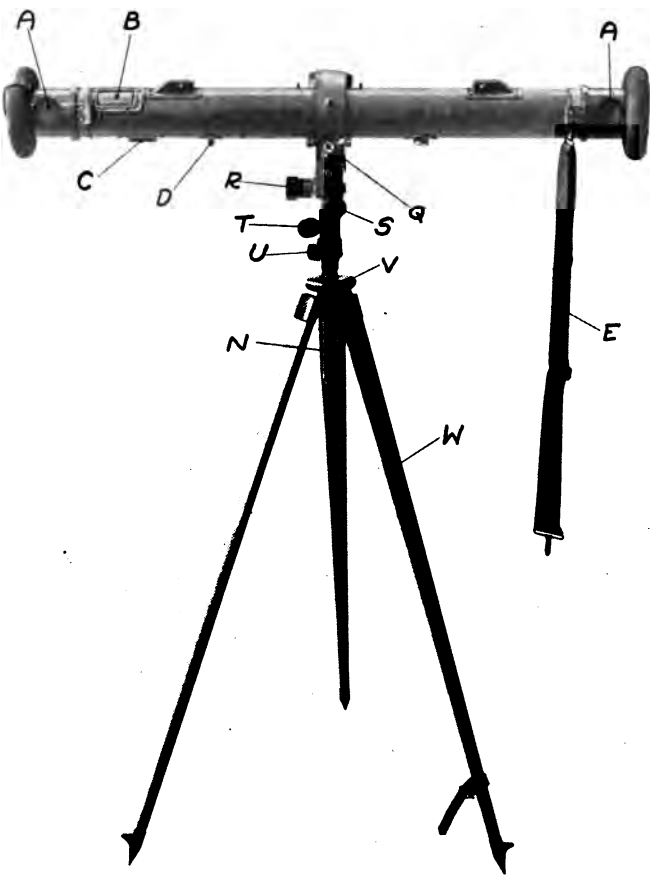
BAUSCH & LOMB, 70 CM. BASE, RANGE FINDER. FRONT VIEW.



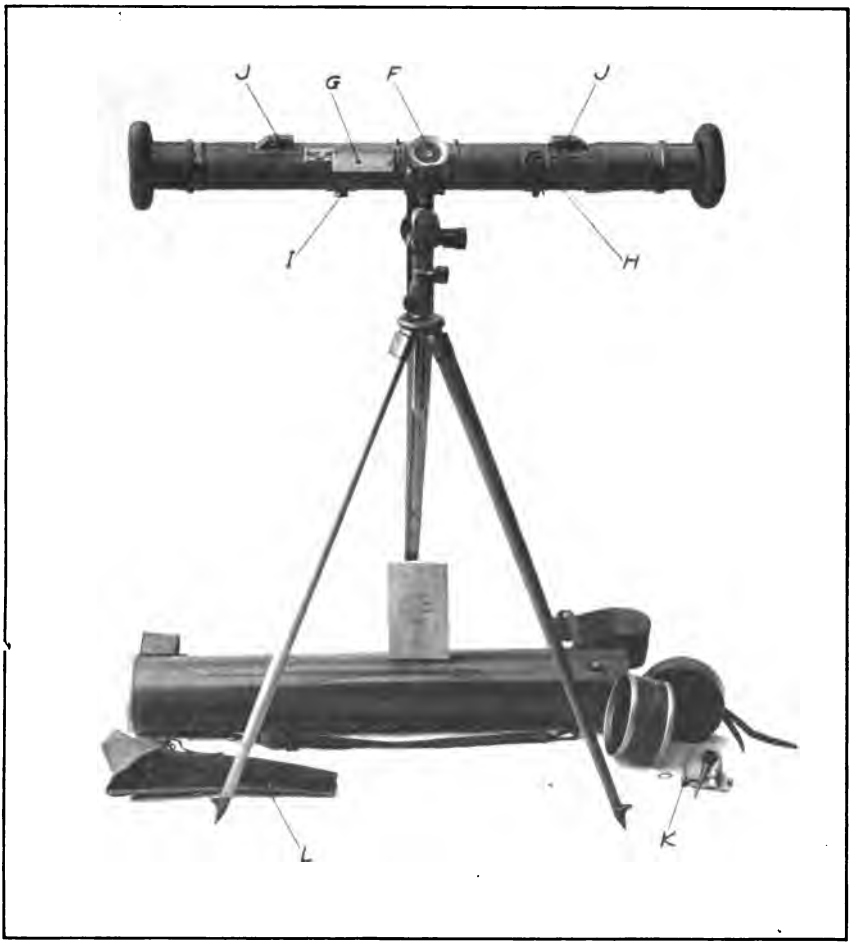
BAUSCH & LOMB, 70 CM. BASE, RANGE FINDER. REAR VIEW.



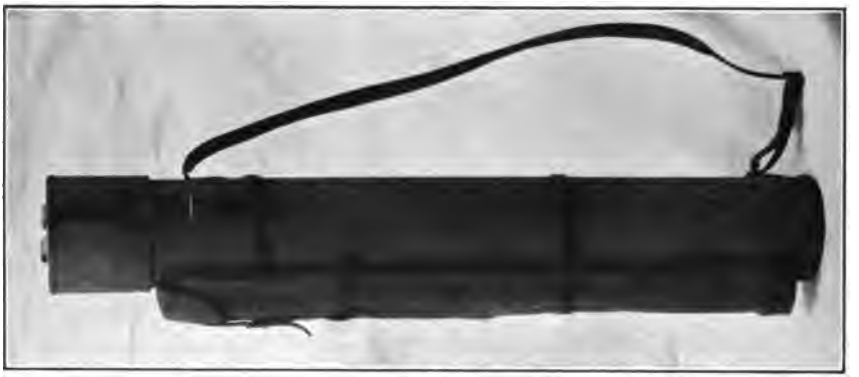
CARRYING CASES FOR BAUSCH & LOMB, 70 CM. BASE, RANGE FINDER.



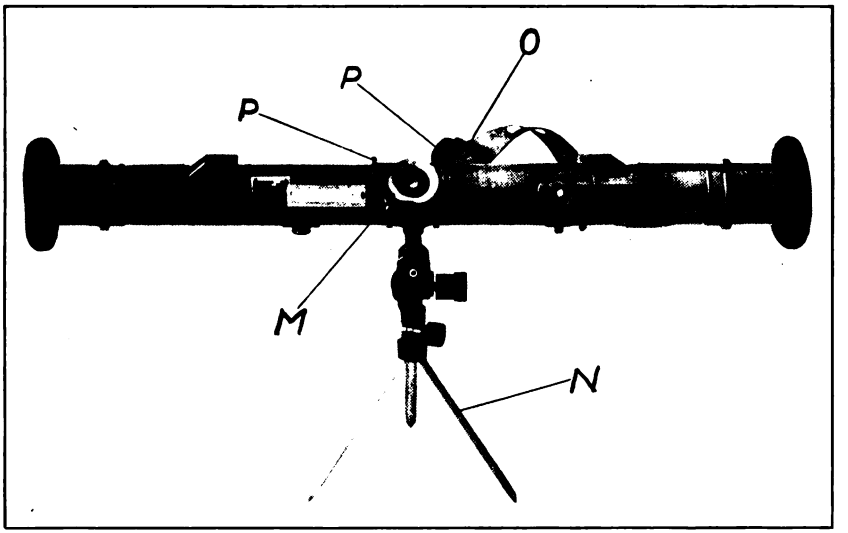
BAUSCH & LOMB, 80 CM. BASE, RANGE FINDER. FRONT VIEW.



BAUSCH & LOMB, 80 CM. BASE, RANGE FINDER. REAR VIEW.



GOERZ, 80 CM. BASE, RANGE-FINDER CARRYING CASE.



BAUSCH & LOMB, 80 CM. BASE, RANGE FINDER, WITH SHORT TRIPOD.